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(71) Applicant Carl-Zeiss-Stiftung Handeland Als Carl Zeiss Heidenheim 89518 Germany

(72) Inventor Schuster Karl Heinz
24 Rehberg Straße, Königsbronn 89551, Germany

(74) Attorney Sang-Goo, Ha
Young-Wook, Ha
Yeo-Bum, Yoon
Hae-Sun, Park

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(54) Radial polarization-rotating optical arrangement and microlithographic projection exposure system incorporating said arrangement

ABSTRACT

An optical arrangement is disclosed wherein an entering

beam is converted into an exiting beam having a total cross section of light which is linearly polarized essentially in the radial direction by rotation. For this purpose, rasters of half-wave plates (41, 42, 4i), a combination of birefringent quarter-wave plate 420 and a circular plate 430 is suggested in combination with a conical polarizer 21'. This arrangement is preferably utilized in the illumination portion of a microlithographic projection exposure system. It is important that the arrangement be mounted behind all asymmetric or polarizing component elements 103a.

REPRESENTATIVE DRAWING

FIG. 1

SPECIFICATION

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described with reference to the drawings wherein:

FIG. 1a is a plan view of a radially polarization-rotating optical arrangement of a raster of half-wave plates for linearly polarized incident light;

FIG. 1b shows the polarization directions of the light beam exiting from the arrangement of FIG. 1a;

FIG. 2 is an elevation view, in section, of a radially polarizing optical arrangement having a conical-frustrum reflector having a brewster angle for circularly polarized or non-polarized incident light;

FIG. 3a is an arrangement incorporating a conical-frustrum reflector and segmented half-wave plates for complete utilization of circularly-polarized light or non-polarized light;

FIG. 3b is a plan view of the arrangement of FIG. 3a as viewed from the light exit end thereof;

FIG. 4a is a radial polarization-rotating optical arrangement having a plate with a central-symmetrical stress-induced birefringence;

FIG. 4b is a plan view of the quarter-wave plate of the arrangement of FIG. 4a;

FIG. 4c is a plan view of the compressive-strain plate of the arrangement of FIG. 4a;

FIG. 4d is a plan view of the birefringent 45.degree. plate corresponding to the arrangement of FIG. 4a;

FIG. 5 is a schematic representation of a microlithographic projection exposure system incorporating a radially polarizing optical arrangement in the illumination portion thereof; and,

FIG. 6 is a schematic representation of a catadioptric projection objective having a radially polarizing optical arrangement of the invention incorporated therein.

<Description of reference numerals of principal elements in the drawings>

11, 12, 1i: cross section

21, 22, 2i: polarization direction

20: conical frustrum

30: transparent part

41: ring beam

51: light source

52: mirror

53: diaphragm

54: objective

55: polarizer

58: reticle

DETAILED DESCRIPTION OF THE INVENTION

OBJECT OF THE INVENTION

FIELD AND BACKGROUND OF THE INVENTION

The invention relates to an optical arrangement which converts an entering light beam into an exiting light beam having light which is linearly polarized in the entire cross section essentially in radial direction.

It is necessary to provide projection exposure systems with a very high numerical aperture in order to achieve the highest resolutions in microlithography. Light is coupled into the resist layer at very large angles. When this light is coupled in, the following occur: light losses because of reflection at the outer resist boundary layer and deterioration of the resolution because of lateral migration caused by reflections at the two boundary layers of the resist to the wafer and to the air (formation of standing waves).

The degree of fresnel reflection is then dependent upon the angle between the polarization direction and the reflection plane. The reflection vanishes when light having an electrical field oscillating parallel to the incident angle incidents at the brewster angle. This provides for optimal in-coupling into

the resist while at the same time providing maximum suppression of the standing waves.

However, disturbances occur for light which is linearly polarized in one direction as described in European patent publications 0,602,923 and 0,608,572. Accordingly, the apparatus disclosed in these publications generate circularly polarized light which is coupled into the resist as the equivalent of unpolarized light. In this way, homogeneity is achieved over the entire image. However, a loss of efficiency is accepted because in each case, the locally perpendicular polarized light component is intensely reflected.

In European patent publication 0,602,923, it is alternatively suggested that linearly polarized light should be orientated in one direction relative to the orientation of a pattern to be imaged as already disclosed in German patent publication 1,572,195. The penetration via a multiple reflection takes place in the longitudinal direction of the structures and not in the direction of the critical resolution. The efficiency of the in-coupling or the reflection at the resist surface is however not homogeneous.

The effect of the polarization on the reflection at the resist layers and the significance of the fresnel coefficients is

described in U.S. Pat. No. 4,899,055 directed to a method for measuring thickness of thin films.

U.S. Pat. No. 5,365,371 discloses a projection exposure apparatus for microlithography wherein a radially directed linear polarization of the light is introduced in order to prevent disturbances because of standing waves in the resist when generating images therein. Two different polarization elements are given, namely, a radial polarization filter composed of a positive cone and a negative cone. This filter is utilized in transmission and effects radial polarization for the reflection because of the fresnel equations. However, it is not disclosed how a complete polarization of the transmitted light is achieved. In the description of U.S. Pat. No. 5,365,371 and in claim 3 thereof, it is required in addition that both parts have different refractive indices. The transmitted part must then however be deflected and cannot: pass in a straight line.

U.S. Pat. No. 5,436,761 has a disclosure identical to that of U.S. Pat. No. 5,365,371 referred to above and includes a single claim wherein no condition is given for the indices of refraction. Furthermore, in claim 4 of U.S. Pat. No. 5,365,371, a plate having segments of radially orientated polarization filter foils is given as is known from U.S. Pat.

No. 4,286,843 (see FIG. 19 and column 9, lines 60 to 68).

Both polarizers are polarization filters, that is, they lead to high light loss and are suitable only for an incoming light beam which is unpolarized or circularly polarized because, otherwise, an intense nonhomogeneity of the intensity would occur over the cross section of the exiting light beam. In the example of FIG. 1, the deflecting mirror 17 causes a partial polarization and therefore the light beam exiting from the polarizer 21 is nonhomogeneous. U.S. Pat. 5,365,371 discloses that the radial polarizer lies in the pupillary plane of the projection objective. A position of the radial polarizer in the objective is problematical because there, the tightest tolerances for an optimal image quality must be maintained.

PROBLEM TO BE SOLVED BY THE INVENTION

It is an object of the invention to provide an optical arrangement which permits a homogeneous coupling of light into optical boundary surfaces with high aperture and with low loss and low scattered light. It is another object of the invention to provide such an arrangement wherein the efficiency and the homogeneity of the exiting light beam are optimized.

Projection exposure apparatus are provided which permit maximum use of the advantages of radial linear polarization with minimum disturbance of the imaging and minimum complexity with respect to assembly.

CONTITUTION OF THE INVENTION

The object of the invention is achieved by a radially polarization-rotating optical arrangement according to claim 1, in which direction of polarization of entering light beam is not selected but is instead rotated.

The subject matters of claims 2 to 5 is directed to the advantageous embodiments which provide different ways of generating the desired polarization distribution. In particular, claim 6 is preferred, since when ring aperture illumination, the incident light at low angles for which low angles the reflectivity is only slightly dependent upon polarization is suppressed.

Claim 7 is very important, which is directed to the integration of a radially polarizing optical arrangement into a microlithographic projection exposure system. In this system, the possibilities of the optics are fully utilized and an improvement in the homogeneity and in the efficiency of

coupling light into the resist layer is achieved because the reflection at the resist layer is reduced uniformly. However, uniform reduction is also achieved at all lenses arranged downstream of the polarizing element. For the light incident at large angles (up to the brewster angle), the effect is the greatest especially where the light intensity (peripheral decay) is at the lowest. The disturbances of the resolution because of scattered light, even at the resist wafer boundary layer, are homogenized and reduced.

An arrangement close to start of the beam path is advantageous because the disturbances caused by stress-induced birefringence at all downstream lenses is minimized and made symmetrical.

For this reason, it is also advantageous for polarization filters (in addition to the preferred polarization-rotating elements) when these elements are mounted in the illuminating system.

In claim 8, the polarization-rotating elements according to claims 1 to 6 are mounted at any desired location in a projection illuminating system which is characterized by improved homogeneity and a much higher efficiency compared to the state of the art.

In another embodiment of claims 9 and 10, a reduction and homogenization of the scattered light which occurs at each lens of the system (even with a low angle of incidence) of the present invention is considered.

On the other hand, asymmetrical optical elements, i.e., rotating mirrors, change the state of polarization and can therefore only be arranged downstream when a reflecting layer having phase correction is utilized. This is especially the case for deflecting mirrors such as for shortening the structural length or as provided in catadioptric projection objectives. If a totally-reflecting prism is utilized as a deflecting element, then a precisely adapted phase-retarding plate must be mounted downstream or the totally reflecting boundary layer must be coated with a phase-correcting layer. Polarizing optical elements such as polarization beam splitters and quarter-wave plates are also disturbing.

Another preferred embodiment is specified in claims 11 and 12.

A polarization-rotating arrangement according to the invention is shown in FIGS. 1a and 1b as it is suitable especially in combination with a honeycomb condenser for the conversion of linearly polarized light. This arrangement is especially

suited for lasers as a light source. The beam cross section is subdivided into a multiplicity of facets (11, 12, 1i) which is, in each case, made of a half-wave plate of birefringent material. Each facet 1i corresponds to a honeycomb element of the honeycomb condenser. The facets 1i are preferably cemented to the honeycomb or placed in wringing contact therewith. For extreme radiation loads, the facets can be separately held and coated to prevent reflection. The honeycomb condensers conventional for microlithographic projection exposure systems have about 10^2 honeycomb elements and the number of the facets is the same.

The main axes (21, 22, 2i) of the facets (11, 1i) are each aligned in the direction of the angle bisector between the polarization direction of the entering linearly polarized light and the radius (which is aligned to the particular optical axis A of the light beam and of the honeycomb condenser) through the center of each facet 1i. In this way, each half-wave plate facet 1i effects the rotation of the polarization direction in the direction of the above-mentioned radius. FIG. 1b shows this effect. Here, the entry surfaces (41, 42, 4i) of the honeycomb condenser are shown with the polarization directions (31, 32, 3i) of the particular component beams which are all aligned radially.

The raster with hexagonal facets 1i is only one embodiment which is especially adapted for the combination with a honeycomb condenser. Other rasters and especially fan-shaped sector subdivisions of the half-wave plates (see FIG. 3b) are also possible. The number of the individual elements can then be in the area of 10^1.

A reduction of the total degree of reflection at an optical boundary surface compared to unpolarized light takes place so long as the component of the light, which is polarized perpendicularly to the plane of incidence, is less than the component of the parallelly polarized light. This boundary case is achieved with only four 90 degree sectors having half-wave plates so that, preferably, more half-wave plates are arranged in the cross section of the light beam especially in the order of magnitude of 10 to 10^2 facets or sectors.

In contrast to the known radial polarizers with sectors as shown in U.S. Pat. Nos. 4,286,843 and 5,365,371, the polarization is filtered out with an insignificant amount of loss; instead, the light is changed at minimal loss in its polarization direction via birefringent elements.

The arrangement shown in FIG. 2 effects a continuous radial direction of the linear polarization for entering unpolarized

or circularly polarized light 40. This arrangement is a polarization filter and is basically known from U.S. Pat. No. 5,365,371 but is new with respect to its details.

The conical frustrum 20 has a through bore and is made of a transparent material, such as glass FK5, quartz glass or CaF_2, with the conical angle α a corresponding to the brewster angle and a dielectric reflection coating on the conical surface 21. The component 45 of the light beam 40 is polarized perpendicularly to the incident plane and is therefore completely reflected. The transmitted beam 4p is polarized completely parallel to the incident plane and is therefore everywhere linearly polarized radially to the optical axis A. The conical frustrum 20 is adapted for an annular aperture illumination and ensures the shortest structural length. A complete cone is also suitable. The conical frustrum 20 is supplemented by a suitable hollow cone 22 to form a cylinder ring whereby the reflective conical surface 21 is protected and the entire structure is easier to mount. The conical frustrum 20 and the hollow cone 22 have the same index of refraction so that the light passing therethrough does so without refraction at the conical surface 21, which is in contrast to U.S. Pat. No. 5,365,371.

FIG. 3a shows, in section, a further embodiment of that shown

in FIG. 2 wherein the reflective component 4s is also utilized so that an arrangement with a substantially lower than 50% light loss is achieved because the polarization is effectively rotated and not filtered.

A transparent part 30 having a conical surface 31 is mounted about the conical frustrum 20' having the conical surface 21' corresponding to FIG. 2 (with an extending cylindrical extension portion). The transparent part 30 has a reflective cone surface 31 parallel to the conical surface 21'. A ring of segments (5i, 5k) of half-wave plates is mounted on the exit surface 32 of the part 30. The main axes (6i, 6k) of the segments are at 45 degree. to the radius in the segment center as shown in FIG. 3b. In this way, and as described with respect to FIG. 1, the radial linear polarization is effected also of the light 4s reflected at the conical surface 21' in the beam 4r parallel to the axis. The effected increase of the light-conductance value is often desired at least for laser light sources. It is important that the arrangement is suitable for unpolarized incident light. By omitting or adding optical glass, the optical path of conical frustrum 20' and transparent part 30 can be adapted.

An arrangement for continuously generating radially linear polarized light is shown in FIGS. 4a to 4d. Here, the

arrangement is for linearly or circularly polarized light at the input with reduced structural length in the direction of the optical axis. It is especially suitable for annular aperture optics.

An annular beam of uniformly linear polarized light 41 impinges on a stack of three planar plates (410, 420, 430) as shown in section in FIG. 6a. Planar plate 410 is a quarter-wave plate which, as FIG. 4b shows, circularly polarizes the through-passing light. If the entering beam is already circularly polarized, then the plate 410 can be omitted. A plate 420 follows and can, for example, be made of glass or quartz glass. The plate 420 is under centrally-symmetrical pressure stress and has therefore stress-induced birefringence. Thickness, material and stress are so selected that the plate 420 is a quarter-wave plate in the outer region touched by the annular beam 41 but with radial symmetry so that the circularly polarized entering light is linearly polarized and with the polarization direction at 45 degree to the radius over the entire cross section as shown in FIG. 4c.

Such a pressure stress always accompanies thermal expansion and temperature gradients when cooling or a compensating thermal treatment in circularly round glass plates (or plates of quartz glass, berylliumfluoride, CaF_2 et cetera). The

pressure stress is normally minimized with the longest possible cooling. Via deliberate cooling, the desired pressure stress can be generated within wide limits and therefore the desired stress-induced birefringence is generated in the exterior region.

A third plate 430 follows which has circular birefringence and rotates the polarization direction by 45 degree. In this way, and as shown in FIG. 4d, the radial polarization of the exiting light extends over the entire cross section.

As in the embodiment of FIGS. 1a and 1b, this embodiment affords the advantage of being especially thin and, as shown in the embodiment of FIG. 2, has the advantage that precise radial polarization is provided without complex assembly of many facets or segments. The main advantage is also the high efficiency because the polarization is rotated and not selected. If, in lieu of an annular beam 41, a complete beam is transmitted through the arrangement, then the core area is simply not influenced.

FIG. 5 is a schematic showing a complete microlithographic projection exposure system with a radially polarizing optical arrangement 55 which is here in the form of a conical-frustrum polarizer according to FIG. 2. Except for this element and its

mounting, all components and their arrangement are conventional. A light source 51, for example, an i-line mercury discharge lamp having mirror 52, illuminates a diaphragm 53. The i-line mercury lamp is tuned to the i-line (atomic emission spectral line of mercury having a wavelength of 358 nm) and is conventionally used in microlithography. An objective 54 (for example, a zoom axicon objective as disclosed in German patent publication 4,421,053) follows and makes possible various adjustments, especially the selection of an annular aperture.

The conical-frustrum polarizer 55, which is suitable for unpolarized entering light, is followed by: a honeycomb condenser 56 and a relay and field optic 57. These parts together serve to optimize illumination of the reticle 58 (the mask) which is imaged by the projection objective 59 at a reduced scale and with the highest resolution (below 1 um) on the resist film 60 of the wafer 61. The numerical aperture of the system lies in the range of values above 0.5 to 0.9. Annular apertures between 0.7 and 0.9 are preferred. The radial polarization of the light after leaving the conical-frustrum polarizer 55 causes the effect of the stress-induced birefringence to be rotationally symmetrical with respect to the optical axis at all of the following optical elements (56, 57, 58, 59). The effect is the greatest at the entrance into

the resist film 60 where the largest inlet angles occur and therefore optimal transmission and minimum reflection are achieved. The sensitive beam path in the projection objective 59 is undisturbed.

The embodiment of the polarizing optical arrangement 55 is not limited to the embodiment of FIG. 2. Especially all polarization-rotating arrangements can be used and, if needed, a polarizer or birefringent plate can be mounted forward of the arrangement for adaptation. Also, a polarization-rotating optical arrangement 55 can be placed at other locations in the overall configuration.

This is especially true when deflection mirrors without phase correction or polarizing elements, such as polarization beam splitters, are used. Then, the polarization-rotating optical arrangement according to the invention is placed behind these elements as viewed in light flow direction. One embodiment is shown in FIG. 6 in the context of a catadioptric projection objective.

FIG. 6 corresponds completely to FIG. 1 of European patent publication 0,602,923 having polarizing beam splitter 103, concave mirror 106, lens groups (102, 105, 108) and quarter-wave plate 104. The polarization-rotating optical element 107

is, however, not a quarter-wave plate for circular polarization and therefore uniform deterioration of the coupling in of light into the resist 109, as described initially herein with respect to European patent publication 0,602,923. The polarization-rotating optical element 107 also is not a means for aligning the uniform linear polarization to a preferred direction of the pattern on the reticle 101. Rather, a radial polarization-rotating optical arrangement 107 is provided in FIG. 6.

The embodiments of FIGS. 1a and 1b and 4 are the best suited here because of the small amount of space available. The advantage is clear, namely, independently of the pattern of the individual case, optimal scatter light suppression and uniform efficiency of the incoupling of light into the resist 109 is achieved.

The radial polarizing optical arrangement 107 is mounted as close as possible behind the deflecting mirror 103a in the almost completely collimated beam path, that is, in a range of moderate angles and divergences of the light rays. Small angles are important for a trouble-free functioning of the birefringent elements. The best effect is achieved when the exit plane of the polarization-rotating elements lies in a plane of the illumination or projection system which is

fourier-transformed to the image plane or in a plane equivalent thereto.

The use of the polarization-rotating optical arrangement, which generates a radially orientated linear polarization on the total beam cross section, is not limited to microlithography.

EFFECTS OF THE INVENTION

The optical arrangement of the preset invention permits a coupling of light into optical boundary surfaces with high aperture and with low loss and low scattered light. Further, the optical arrangement of the present invention permits the uniform efficiency for light coupling into resist and optimized reduction for scattered light without depending on samples.

(57) *CLAIMS*

1. An optical arrangement for rotate an entering light beam into a exiting light beam having a linear polarization essentially directed radially at the entire cross section,

wherein the polarization of said entering light beam is rotated and not selected.

2. The optical arrangement of claim 1, said entering light beam with linear polarization defining an optical axis (A) and said optical structure including more than four half-wave plates 41, 41; 4i disposed in a raster, segment or facet configuration; said half-wave plates 41, 42; 4i having respective preferred directions 21, 22; 2i so arranged that each half-wave plate rotates the polarization direction of the penetrating linear polarized light in the direction of a radius 31, 32; 3i which cuts through the corresponding half-wave plate and is directed to said optical axis.

3. The optical arrangement of claim 2, further comprising a reflective polarizer having a conical surface shaped polarizing surface or a conical-frustrum surface shaped polarizing surface; and, said half-wave plates 5i being mounted in the beam path of light reflected at said reflective polarizer.

4. The optical arrangement of claim 1, further comprising a strain birefringent quarter-wave plate 420 under compressive strain in radial direction and a circular double refracting plate 430 rotating at 45 degree.

5. The optical arrangement of claim 4, further comprising

the normal quarter-wave plate so that linear polarized light is used.

6. The optical arrangement of one of claims 1 to 4, wherein said optical arrangement is illuminated by a ring aperture.

7. A microlithographic projection exposure system comprising a radially polarization-rotating optical arrangement over cross section of light beam which is rotationally symmetric with respect to an optical axis in a plane of the exposure system.

8. A microlithographic projection exposure system comprising the radially polarization-rotating optical arrangement of one of claims 1 to 6.

9. The microlithographic projection exposure system of claim 8, the radially polarization-rotating optical arrangement 55 is disposed between a light source 51 and a reticle 58.

10. The microlithographic projection exposure system of claim 7, the radially polarization-rotating optical arrangement 107 is mounted behind a light rotating mirror

103a, which is arranged non-symmetrically with respect to a last polarized optical axis in downstream of light beam.

11. The microlithographic projection exposure system of claim 9, a honeycomb lens 56 is provided to the illumination portion, wherein a facet of the optical arrangement are assigned to each honeycomb of the honeycomb lens 56 so that the honeycomb lens is connected to the polarization-rotating optical arrangement according to claim 2.

12. The microlithographic projection exposure system of claim 8, the radially polarization-rotating optical arrangement is mounted in collimated beam path.

13. The microlithographic projection exposure system of claim 8, the radially polarization-rotating optical arrangement 107 is mounted behind a light rotating mirror 103a, which is arranged non-symmetrically with respect to a last polarized optical axis in downstream of light beam.

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(71) 출원인	유니온 스위치 앤드 시그널 인코오포레이티드 미국 미합중국 펜실베니아 15219 피츠버그 테크놀로지 드라이브 1000 칼 짜이스 슈티프퉁 한델른트 알스 칼 짜이스, 카. 크나트치히, 뭘러 리쓰만 독일 독일연방공화국 89518 하이덴하임
(72) 발명자	기라오 테오 시이 미국 미합중국 펜실베니아 15238 피츠버그 스위트검 로드 260 구날슨 크리스챤 미국 미합중국 펜실베니아 15206 피츠버그 셸러스 스트리트 6206 보일 프랭클린 미국 미합중국 펜실베니아 15237 피츠버그 호그 드라이브 345 슈스트 칼 하인즈 독일 독일연방공화국 89551 쾨니히스브론 레흐베르크슈트라쎄 24
(74) 대리인	하상구 하영욱 윤여범 박해선

(77) 심사청구	없음
(54) 출원명	방사 방향으로 편광회전하는 광학장치 및 이를 갖는 마이크로리소그래피 투사형 노출 장치

요약

광학장치는 전체 횡단면에서 방사방향으로 직선 편광된 광으로 입사하는 광을 선택이 아닌 회전에 의해 나가는 광 빔으로 변형시킨다. 이를 위해 반파장 플레이트(41,42,4i)로 된 래스터, 방사 방향 아축 스트레인 하에 있는 스트레인 복굴절 1/4 파장 플레이트(420)와 원 복굴절하는 45°회전하는 플레이트(430)로 이루어진 결합물이 원추 편광기(21')와 연결되어서도 제공된다. 마이크로리소그래피 투사노출장치에서 이 장치는 바람직하게는 조명부재에 배열되어 있다. 모든 비대칭 또는 편광하는 소자(103a) 뒤에 배열이 중요하다.

대표도 : 제1a도

대표도

도1

명세서

[발명의 명칭]

방사방향으로 편광회전하는 광학장치 및 이를 갖는 마이크로리소그래피 투사형 노출장치

[도면의 간단한 설명]

제1a도는 직선 편광되는 입사광에 대해 1/2파장 플레이트의 래스터로부터 방사방향으로 편광회전하는 광학장치의 평면도.

본 내용은 요부공개 건이므로 전문 내용을 수록하지 않았음.

(57) 청구의 범위

청구항 1.

들어오는 광 빔을 전체 횡단면에서 방사방향으로 직선 편광된 광을 가지고 나가는 광 빔으로 변형시키는 광학장치에 있어서, 들어오는 광 빔의 편광방향은 회전되며 선택되지 않는 것을 특징으로 하는 광학장치.

청구항 2.

제1항에 있어서, 직선 편광된 들어오는 광 빔, 광축(A) 및 편광방향(P) 및 4개 이상의 반파장 플레이트(41,41 ; 4i)의 래스터, 세그먼트 또는 절단면 장치를 가지며, 이것의 우선 방향(21,22 ; 2i)은 각각의 반파장 플레이트(41,42 ; 4i)가 상기 반파장 플레이트와 교차하는 광축(A)을 향한 반경(31,32 ; 3i)의 방향으로 직선편광된 관통하는 광의 편광방향을 전환하도록 정렬되는 것을 특징으로 하는 광학장치.

청구항 3.

제2항에 있어서, 원추 보호면 또는 원추대 보호면 형상인 편광하는 표면(21')을 갖는 반사 편광기가 제공되며 반파장 플레이트(5i)가 반사 편광기에서 반사되는 광의 빔에 배열되는 것을 특징으로 하는 광학장치(제3a도, 제3b도).

청구항 4.

제1항에 있어서, 방사방향의 압축 스트레인 하에 있는 스트레인 복굴절 1/4파장 길이 플레이트(420)와 원형으로 복굴절하는 45°정도 회전하는 플레이트(430)로 이루어지는 것을 특징으로 하는 광학장치(제4a도 내지 제4d도).

청구항 5.

제4항에 있어서, 일반적인 1/4파장 플레이트(410)가 앞에 배열됨으로써 직선 편광된 광이 이용될 수 있는 것을 특징으로 하는 광학장치.

청구항 6.

제1항 내지 제5항 중 어느 한 항에 있어서, 링 어퍼처 노출하는 것을 특징으로 하는 광학장치.

청구항 7.

노출 시스템의 한 평면에서 광축에 대해 회전 대칭인 광 빔 횡단면에서 방사방향 편광을 포함하는 것을 특징으로 하는 마이크로리소그래피 투사노출장치.

청구항 8.

방사방향으로 편광회전하는 제1항 내지 제6항 중 어느 한 항에 따른 광학장치를 포함하는 것을 특징으로 하는 마이크로리소그래피 투사노출장치.

청구항 9.

제8항에 있어서, 상기 방사방향으로 편광회전하는 광학장치(55)가 광원(51)과 레티클(58) 사이에 배열되는 것을 특징으로 하는 마이크로리소그래피 투사노출장치.

청구항 10.

제7항에 있어서, 상기 방사방향으로 편광회전하는 광학장치(107)는 마지막의 편광하는 광축에 대해 대칭이지 않는 부재, 특히 마지막이 회전거울(103a) 뒤에 광의 흐름 방향으로 배열되는 것을 특징으로 하는 마이크로리소그래피 투사노출장치.

청구항 11.

제9항에 있어서, 상기 조명부재에 벌집형 렌즈(56)가 제공되며, 상기 벌집형 렌즈(56) 각각의 벌집 형체에 광학장치의 절단면이 할당되어, 제2항에 따른 방사방향으로 편광회전하는 광학장치와 연결되는 것을 특징으로 하는 마이크로리소그래피 투사노출장치.

청구항 12.

제8항에 있어서, 상기 방사방향으로 편광회전하는 광학장치가 콜리메이트 된 빔 경로에 배열되어 있는 것을 특징으로 하는 마이크로리소그래피 투사노출장치.

청구항 13.

제8항에 있어서, 상기 방사방향으로 편광회전하는 광학장치(107)는 마지막의 편광하는 광축에 대해 대칭이지 않는 부재, 특히 마지막의 회전거울(103a) 뒤에 광의 흐름 방향으로 배열되는 것을 특징으로 하는 마이크로리소그래피 투사노출장치.

※ 참고사항 : 최초출원 내용에 의하여 공개하는 것임.

도면

도면 1

(a)